



CENTRE NATIONAL D'ÉTUDES SPATIALES

# **43<sup>rd</sup> ARGOS OPSCOM**

**New London, USA  
June 2009**

## **D3 – ARGOS INSTRUMENTS**

## **ARGOS-1 instruments :**

- no more Argos-1 instruments operational from 2007

## **ARGOS-2 instruments :**

- 4 instruments of second generation (NOAA-15, 16, 17 and 18)
- the processing unit DRU#8 of NOAA-18 is failed : a few percent of messages are lost over the most crowded areas
- bandwidth of 80 kHz
- telemetry bit rate = 2560 bits/s
- NOAA-15 to 18 satellites record data on-board, then download them to Fairbanks and Wallops stations.
- “pseudo-message” mode activated on NOAA-16 allowing to perform narrowband interferer location



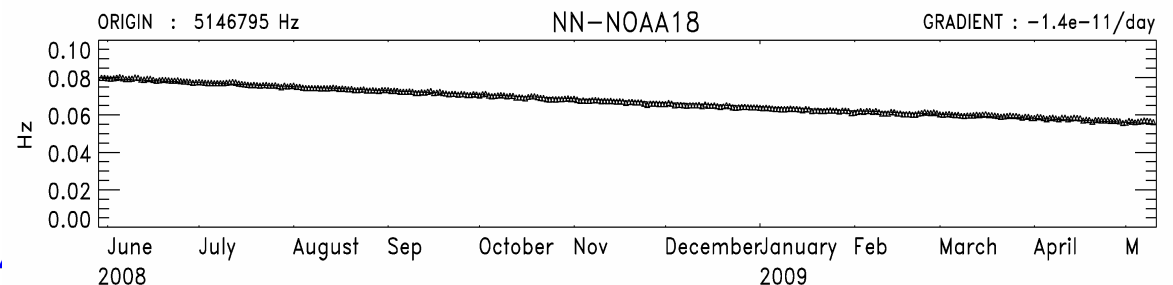
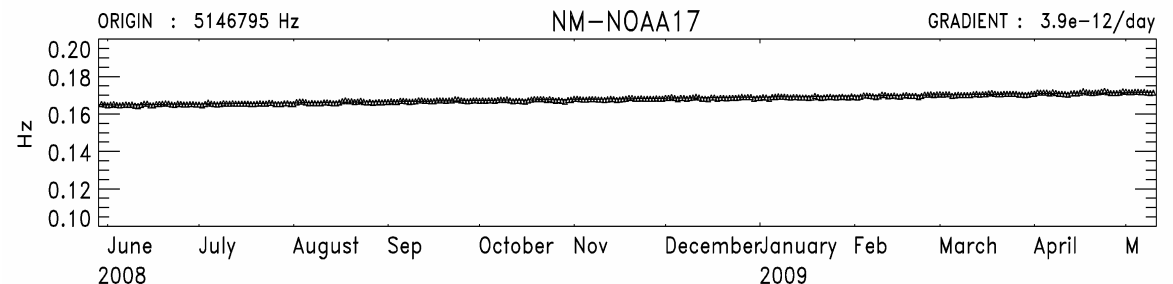
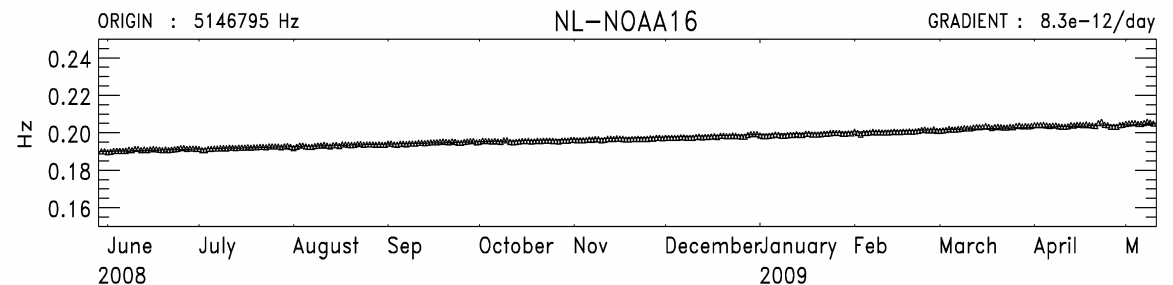
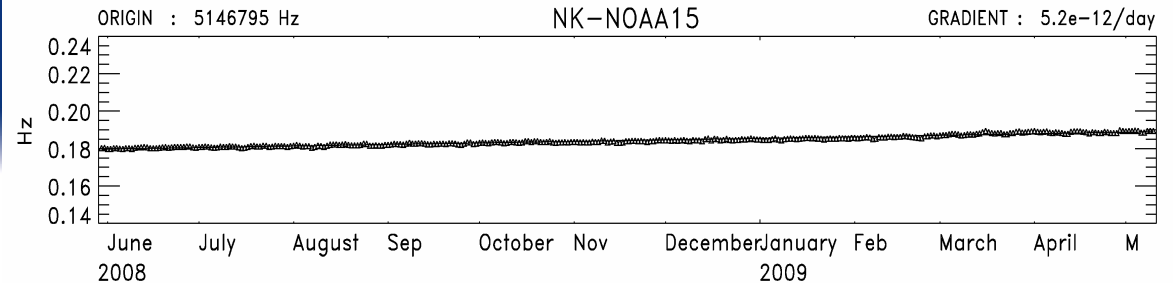
## USO monitoring on NOAA satellites

Ultra-Stable Oscillator is particularly monitored by CNES and by CLS since most of the instruments functions are referenced to this clock.

More particularly, all time-tagging and frequency measurements depend highly on the oscillator stability.

Gradient  $\sim 1.10^{-11}/\text{day}$

### Evolution of onboard USO frequency over the last months



## ■ ARGOS-3 instruments :

- ◆ 5 instruments of third generation (Metop-A/B/C, NOAA-19, SARAL)
- ◆ 2 in-orbit (Metop-A, NOAA-19)
- ◆ full redundant digital instruments
- ◆ bandwidth of 80 kHz for low data rate at 400 bps (capacity of 8 Erlang at 65%, 11 Erlang at 50%)
- ◆ new type of low data rate platform with data encoding
- ◆ bandwidth of 30 kHz for new high data rate at 4800 bps (capacity of 1 Erlang at 65%)
- ◆ telemetry bit rate = 2560 bps (NOAA-19) or 7860 bps (other sat.)
- ◆ downlink at 465.9875 MHz and 400 bps to transmit broadcast or short messages to platforms and to acknowledge uplink messages
- ◆ no “pseudo-message” mode on Argos-3

## **METOP-A.**

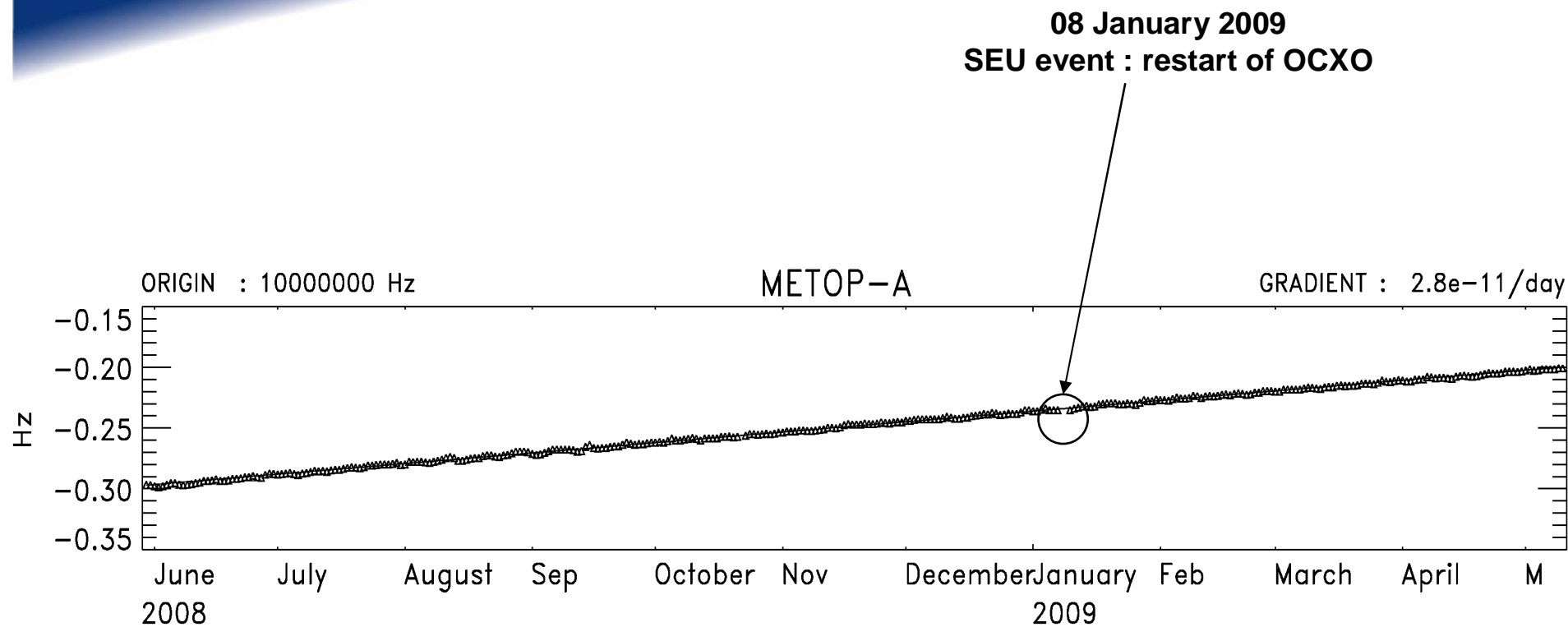
- Flight Model n°2 launched from Baïkonour on 19 Oct 2 006.
  - **Switch-on of Nominal side (side 1) on October 26th, 2006**
- One main anomaly : mission Telemetry corruption
- **Switch-on of Redundant side (side 2) on March 22nd, 2007.**
  - SIOV Review hold in Eumetsat on 28-29 March, 2007.
    - ✓ operational procedure to detect TLM corruption asap
    - ✓ operational procedure to restart instrument and to upload the patch in case of new occurrence of TM corruption
  - All is nominal at instrument level from 22 March 2007..
  - **Argos-3 is now considered as OPERATIONAL on side 2**

## Argos-3 on Metop-A Telemetry Corruption Anomaly

- The corruption of Mission Telemetry occurred 4 times on side 1:  
22/11/06   01/01/07   29/01/07   13/03/07
- Side 2 of instrument was activated on 22/03/2007 and has been working nominally from this date (no anomalies)
- Cause of the anomaly is due to a deficiency of the FIFO ATMEL M67205 (R/W pointers and/or flags logic) and a lack of filtering on the transients of Read/Write signals commanding the FIFO.
- A new FIFO M67206H ATMEL more robust to external environment has been implemented on the A-DCS management boards of the 4 other A-DCS. Some filters have also been included on the Read/Write signals.
- In parallel of the HW retrofit, an upgrade of the management SW has been done in order to correct some minor anomalies detected on Metop-A and to avoid the transmission of any patches after a switch-off of the instrument.
- Remark : HW retrofit not performed on NOAA-N'.

## **METOP-A. SEU events**

- 27/08/2007 : loss of all low data rate platforms :
  - solved via a reset of the processing board (sent by master beacon)
  - 7 days of mission unavailability
- 27/11/2007 : Watch-dog time-out due to a double memory error
  - solved via an instrument restart
  - < 1 day of mission unavailability
- 26/08/2008 : loss of low data rate messages with frequency < 401.625 MHz
  - solved via a reset of the processing board (sent by master beacon)
  - no unavailability for platforms > 401.625 MHz
  - 1 month of unavailability for platforms < 401.625 MHz
- 08/01/09 : loss of all platforms (low data and high data rate)
  - solved via an instrument restart
  - 1.5 day of mission unavailability





### **NOAA-N'.**

- Flight Model n°3 launched from Vandenberg on 6 Feb 2009.
- The NOAA-N' Argos instrument is identical to the METOP ones, excepted the DC/DC converter card that has been modified to decrease the current ripple (the modification implying a power consumption increase).
- The instrument has not been damaged by the fall, has been upgraded (processing software) and has been delivered again in September 2005 in Lockheed Martin (Sunnyvale, CA).
- A new version of management software (v 1.9) was uploaded in June 2008 in LMSCC.

Instruments dismounted from the satellite on 6 June and mounted again on 16 June.

DET (Detailed Electrical Tests) performed with CNES support : 18 - 20 June 2008.

SEPET Tests performed by LMSCC in November 2008.

- Nota : the hardware retrofit (FIFO replacement) has not been performed

➤ **Switch-on of RPU (side 1) on February 12..**

RPU only. All HK parameters nominal.

Good level of performance (see commissioning results).

➤ **Switch-on of TXU (side 1) from February 23 to March 2**

Temporary switch-on authorized by FCC (potential interference with AICC).

All HK parameters are nominal.

But : downlink signal is measured 5 to 10 dB below Metop-A one !

➤ **Switch-on of TXU (side 1) on April 20**

Level is low (lower than in February) and variable. TXU switched-off on April 21.

➤ **Switch-on of TXU (side 2) on April 27**

At the beginning, the level is rather the same as the one measured on TX1 end of February, then the level decreases and varies.

TXU (side 2) switched-off on April 29.

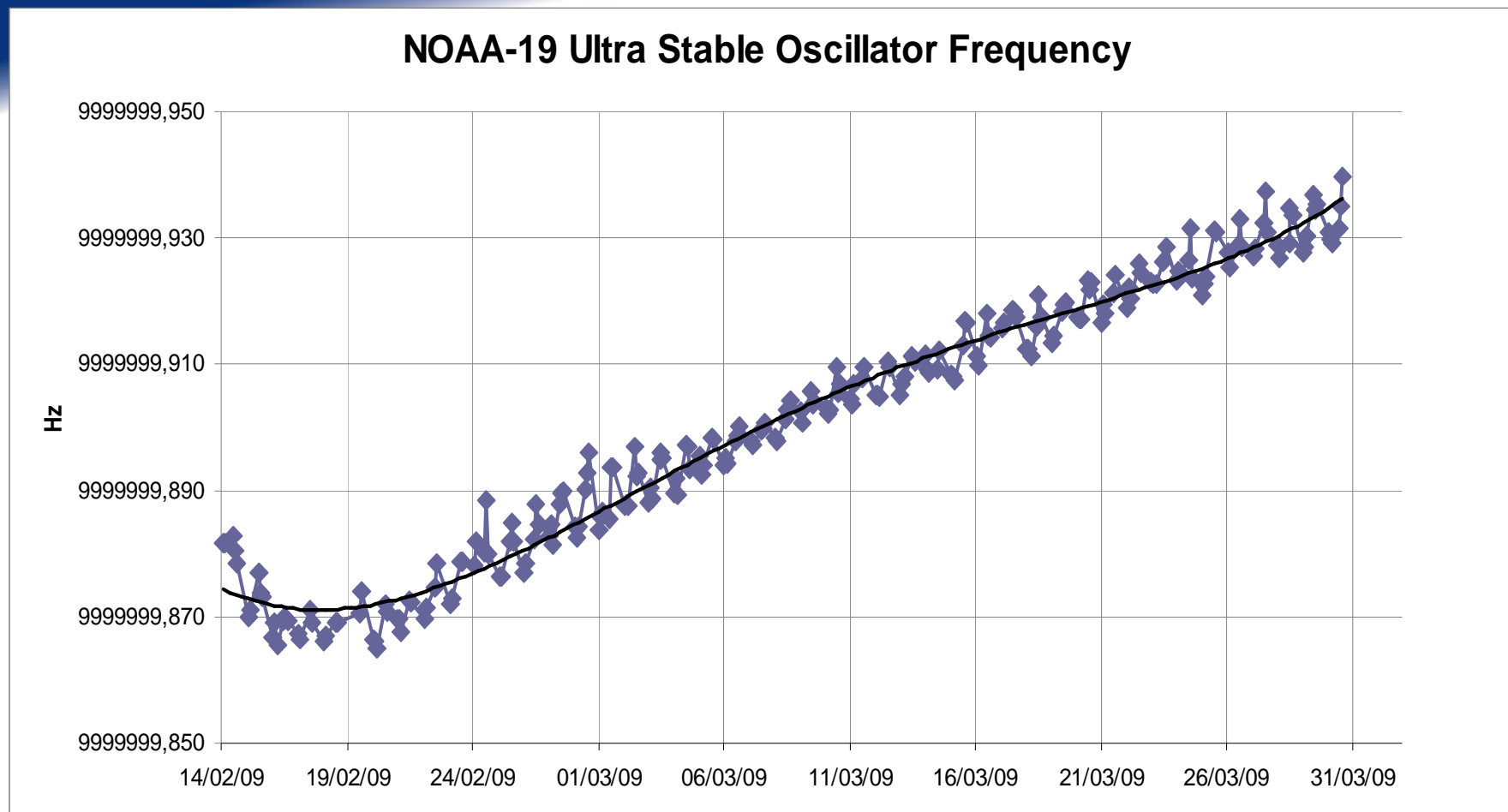
A Group is in charge of investigation of the anomaly.

➤ **Switch-on of TXU (side 1) on May 18**

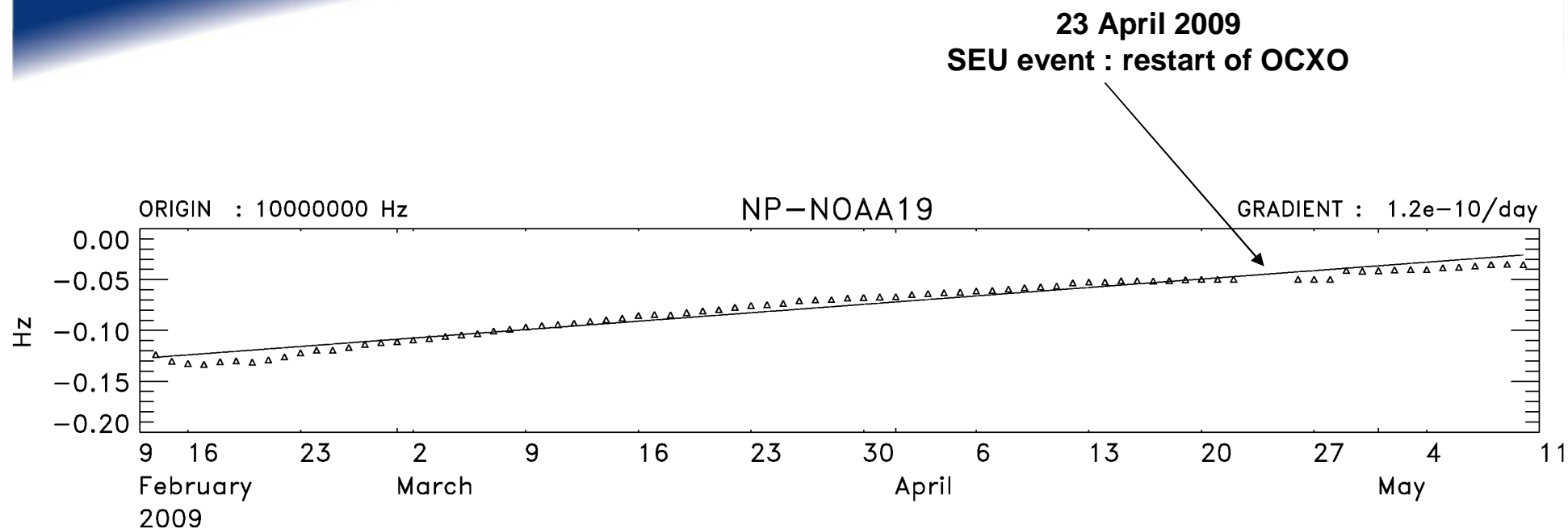
- IOT test performed in Toulouse (CNES) by using :
  - ♦ Argos reference and orbitography platforms
  - ♦ 3 Master Beacons in Fairbanks, Svalbard and Toulouse
  - ♦ Test beacons transmitted via the CNES beacon simulator
  - ♦ All user platforms over the world (9000 platforms seen every day)
  - ♦ Mission telemetry received from NESDIS then CLS
  - ♦ Processing programs developed by CNES and CLS

## **NOAA-N'. SEU events**

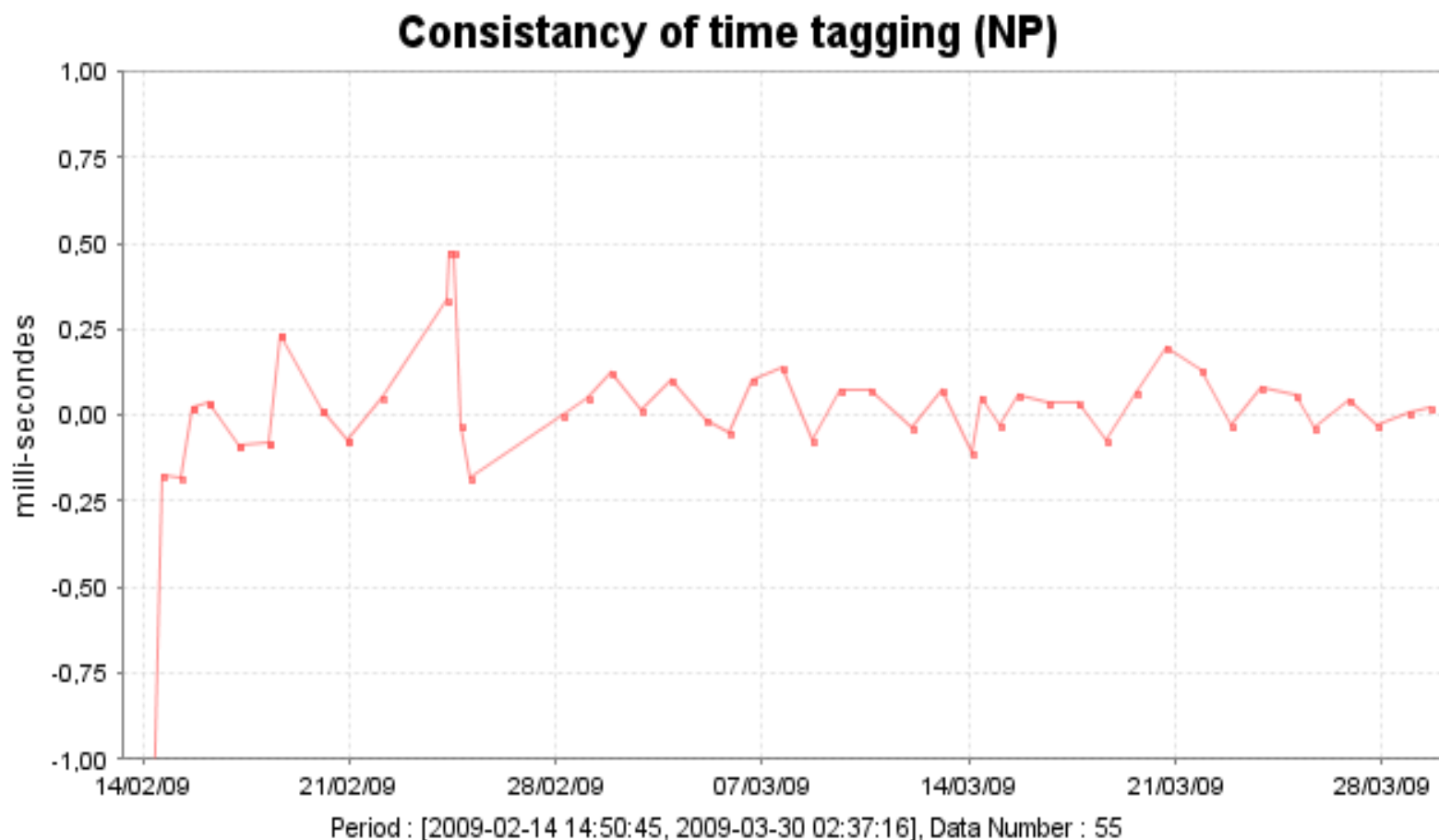
- 23/04/2009 : loss of all platforms in the mission telemetry
  - concerns low data and high data rate platforms
  - same signature as the one encountered on Metop-A (8 Jan 09)
  - event identified when satellite flying in the SAA (South Atlantic Area)
  - solved via an instrument restart (command RPU SW Restarat)
  - 1.5 day of mission unavailability



**USO frequency is 9.999 999.9 Mhz i.e. within the nominal range 10.0 MHz +/- 5 Hz**  
**USO stability is as expected, around 1 mHz per day (  $< 10^{-10}$  /day)**



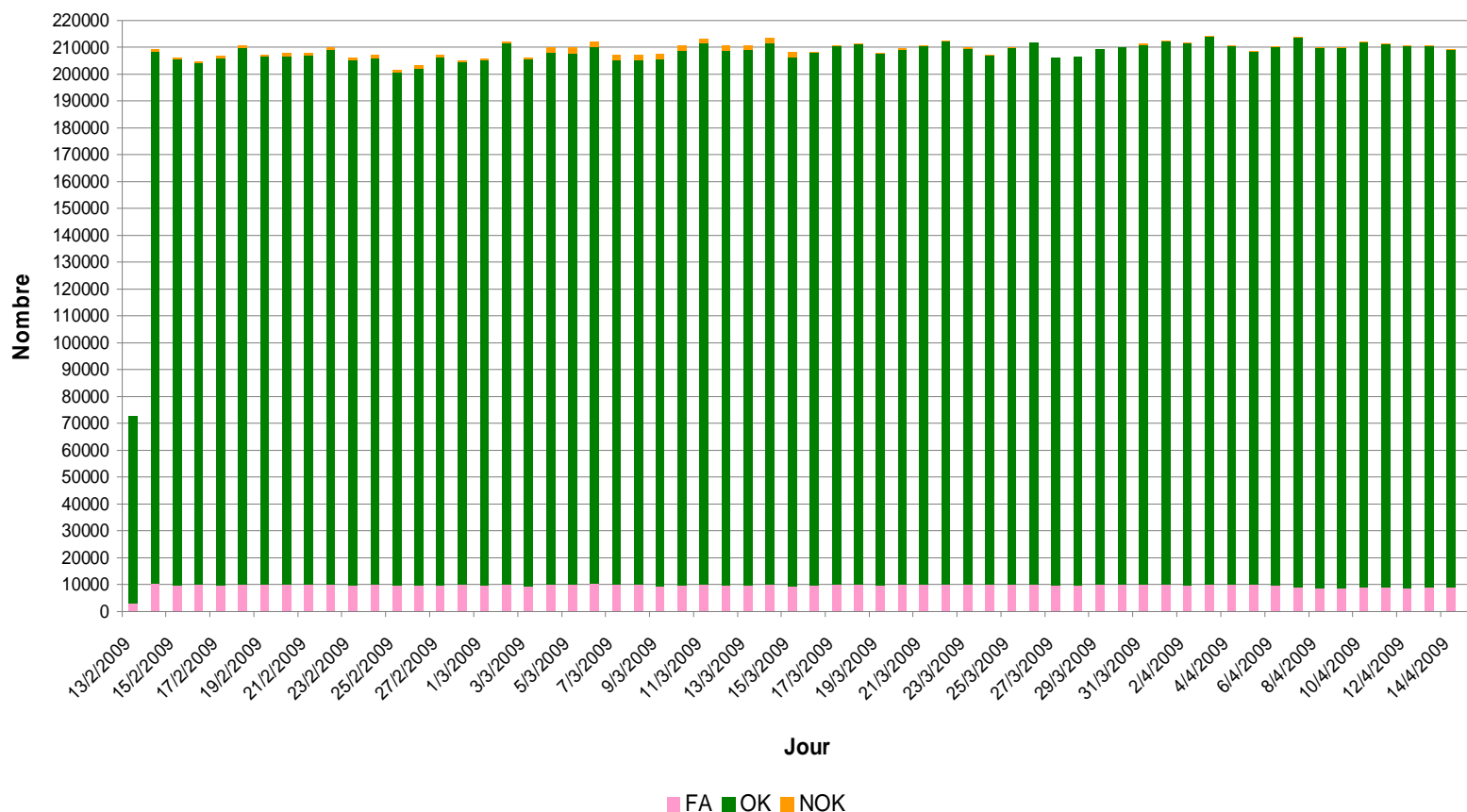
**Consistent with Metop-A oscillator during the first months in orbit**



**Calibration of on-board time is tracked with an accuracy of 100 us as expected**

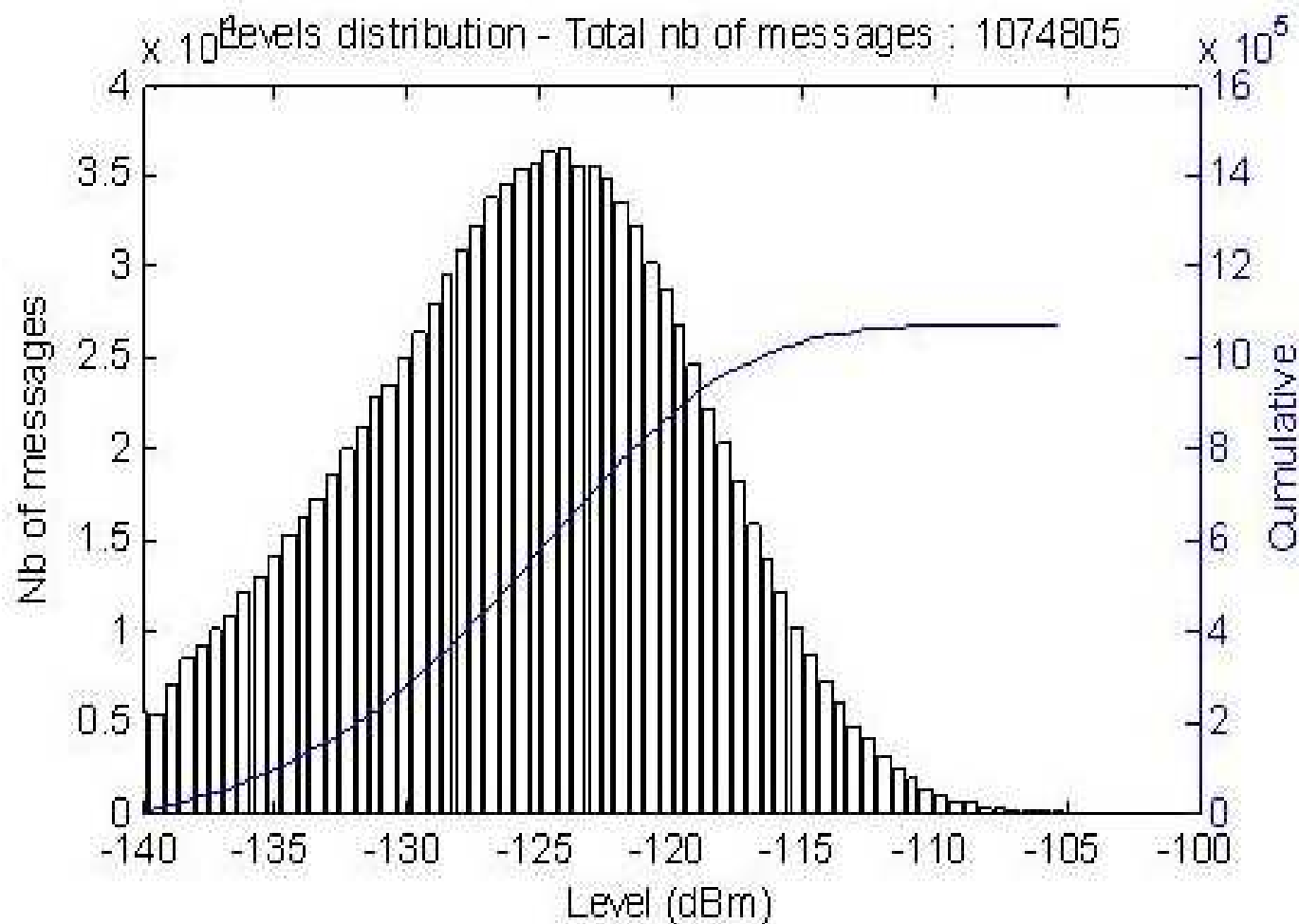
# Processing of NOAA-N' A-DCS Mission telemetry

**NOAA-19 : number of A-DCS Messages per day**  
**Périod from 13/02/2009 to 15/04/2009**  
**> 200 000 msg received per day as expected**

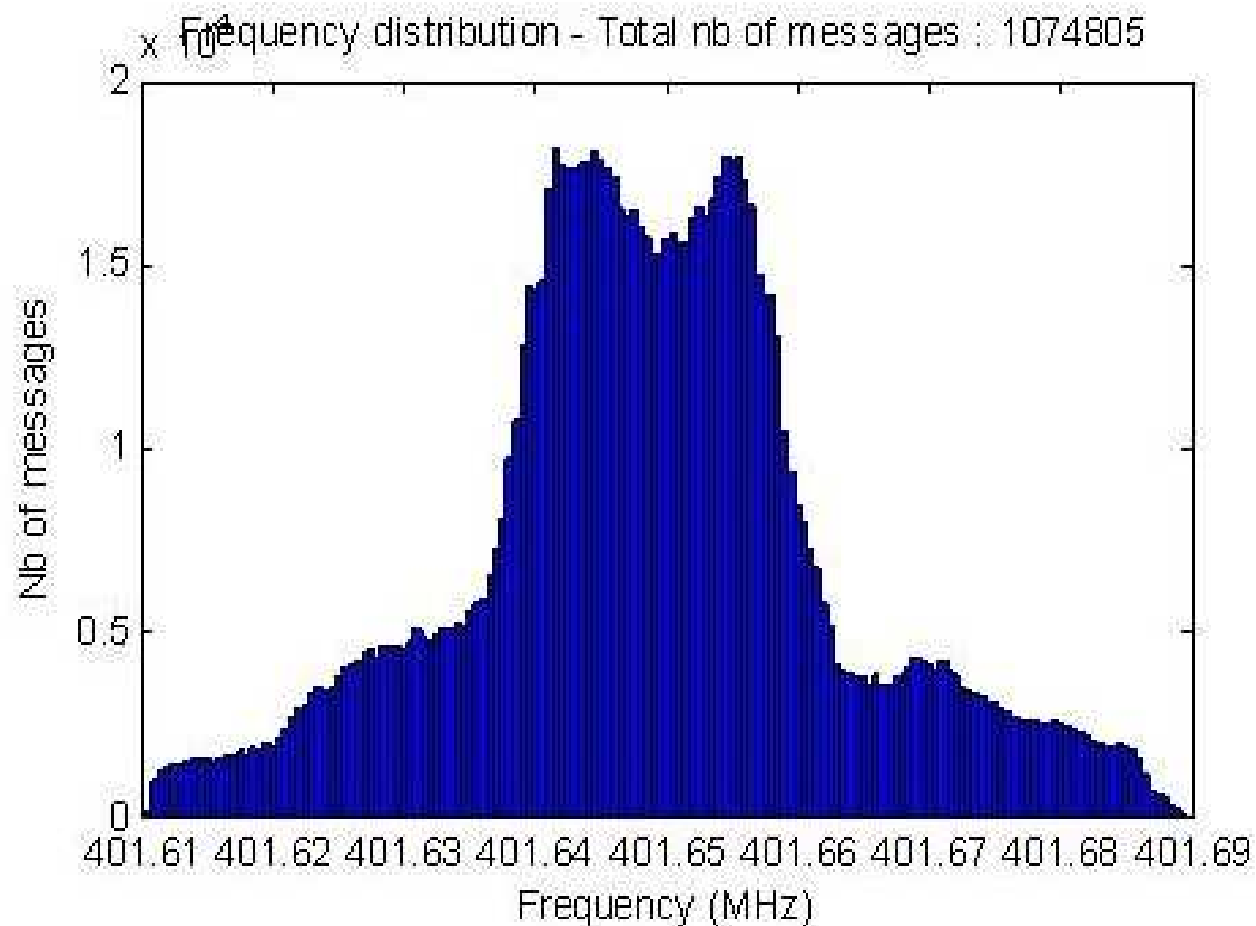




## Histogram of levels received on-board (all platforms) (obtained with 1 074 805 platforms msg)

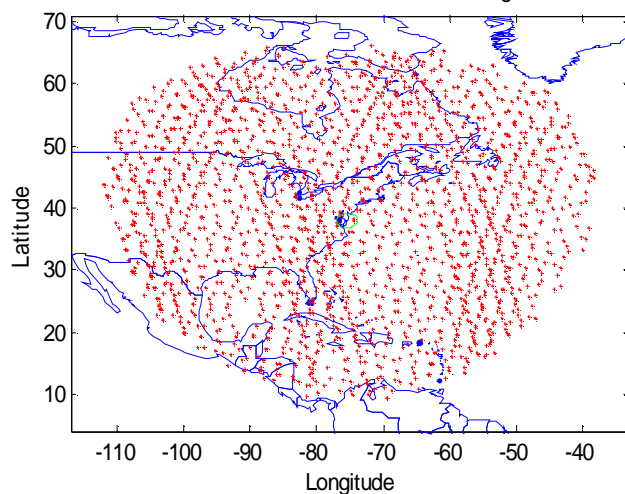


## Histogram of frequencies received on-board (all p/f) (obtained with 1 074 805 platforms msg)

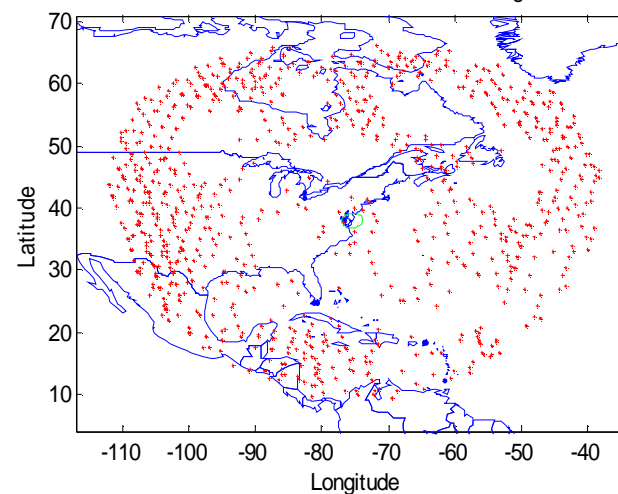


Platform 01D81 visibility by NOAA-19 A-DCS from 02-Mar-2009 to 15-Mar-2009

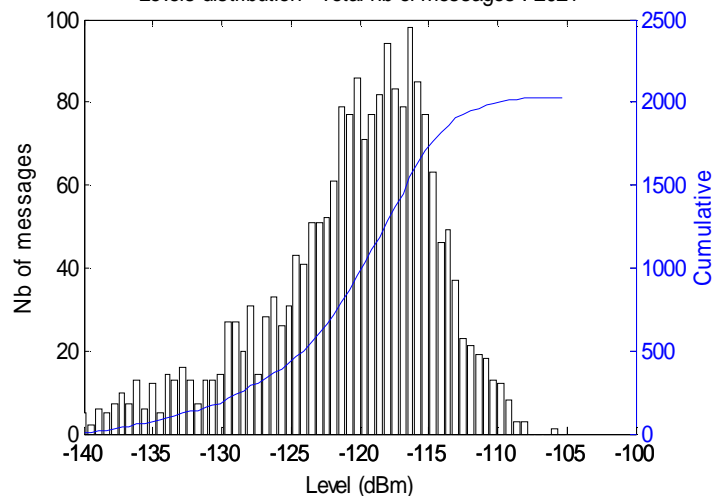
Levels -140 to -100 dBm - Number of messages : 2021



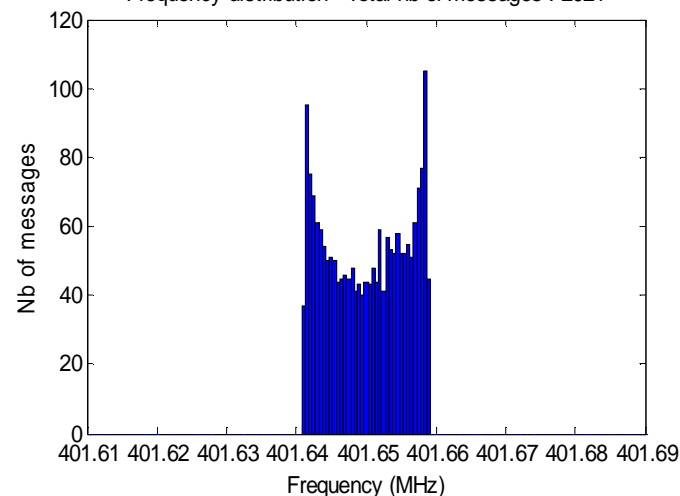
Levels -140 to -120 dBm - Number of messages : 959



Levels distribution - Total nb of messages : 2021



Frequency distribution - Total nb of messages : 2021

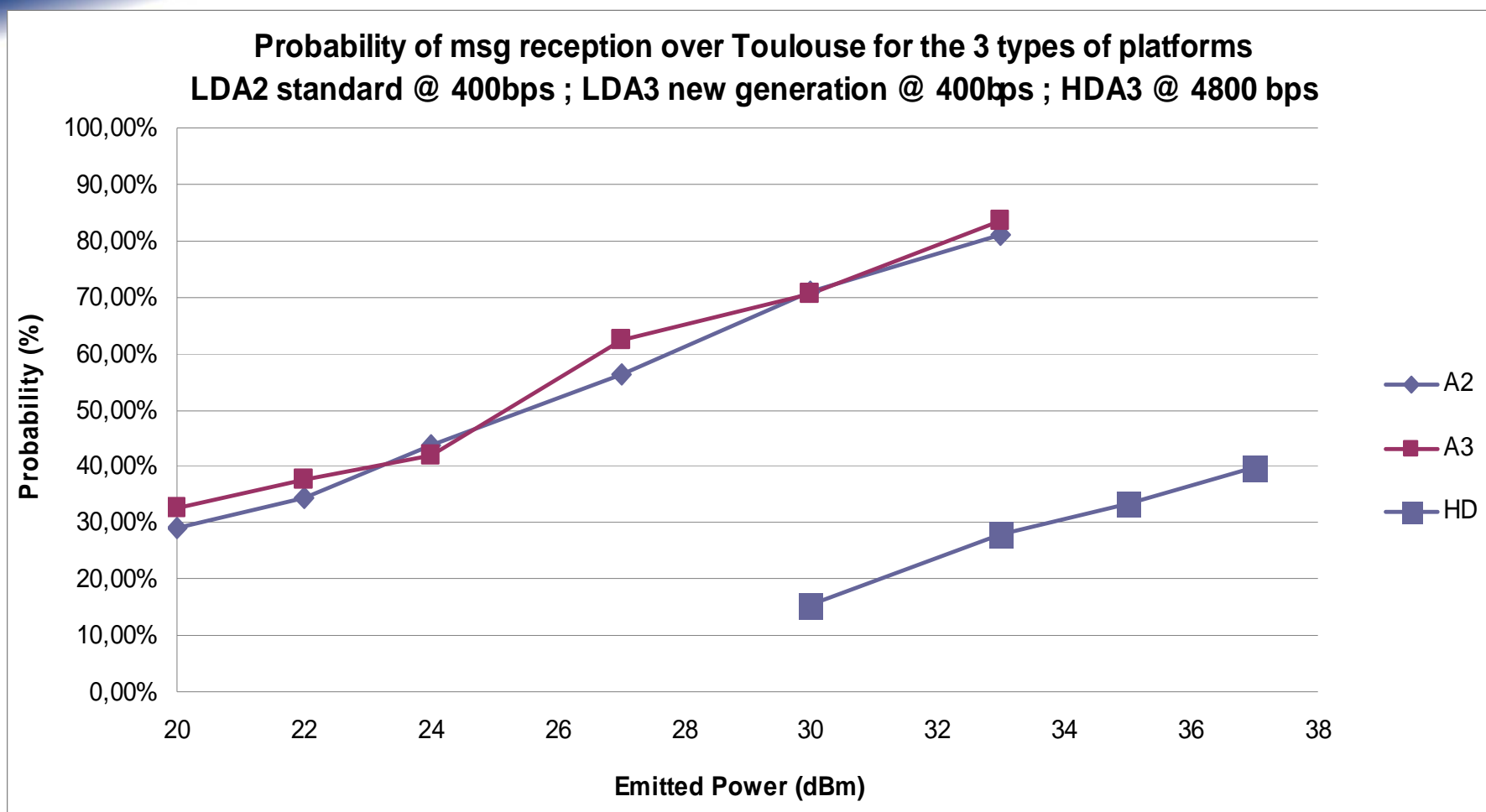


## Metop-A

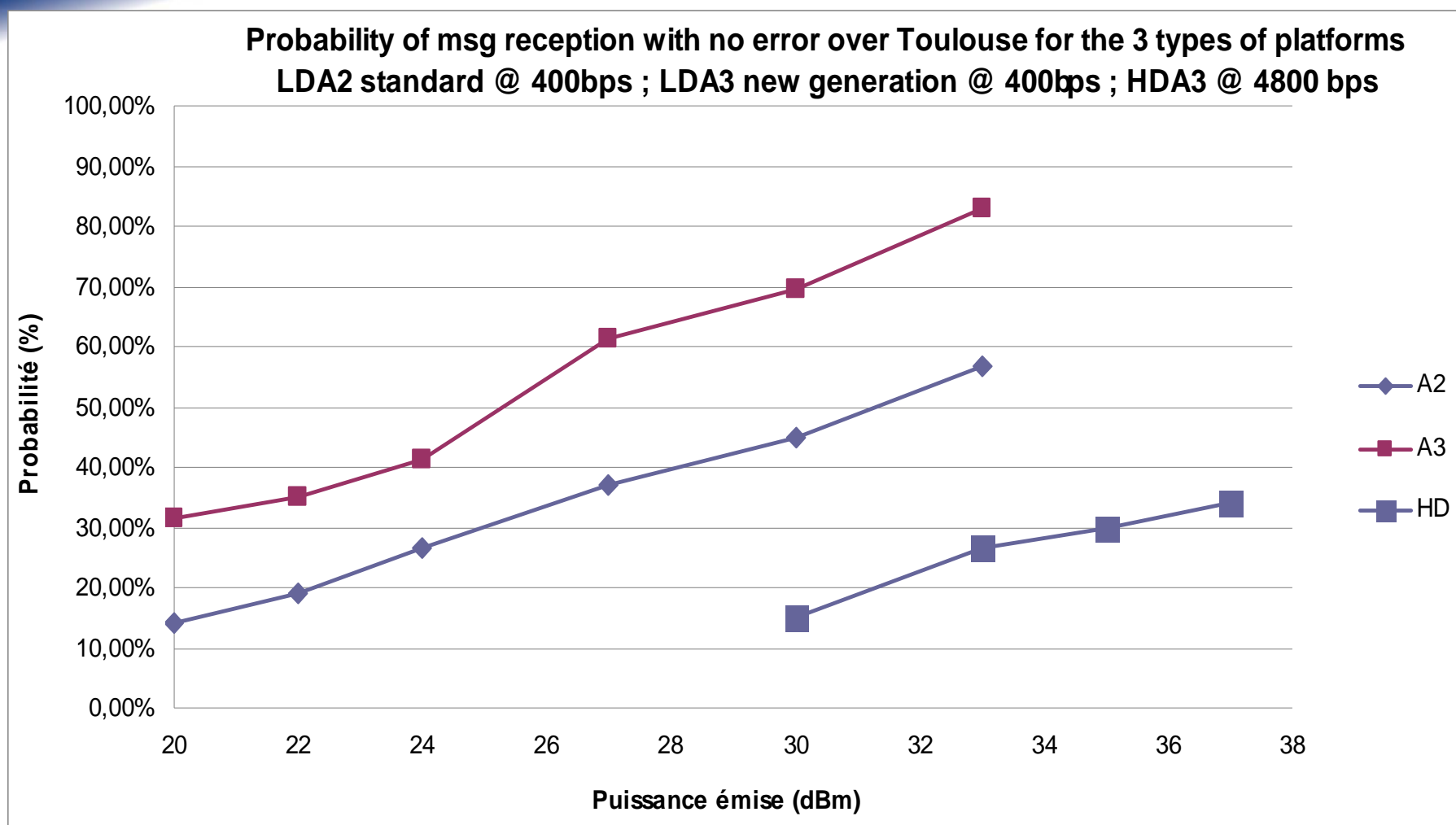
Idbalise	NbLocGlo	NBlocSel	meanError (km)	deltaLon (km)	deltaLat (km)	sigLon (km)	sigLat (km)
1	217	82	0,176	-0,026	0,091	0,171	0,18
108	335	155	0,132	-0,023	-0,013	0,104	0,115
109	137	68	0,202	-0,009	0,083	0,21	0,167
110	166	79	0,198	-0,02	-0,008	0,205	0,158
111	164	76	0,191	-0,015	-0,015	0,216	0,112
112	183	82	0,197	0,043	0,049	0,177	0,162
113	132	65	0,152	-0,024	-0,013	0,115	0,166
116	129	65	0,223	-0,076	0,078	0,202	0,201
118	174	79	0,198	-0,005	-0,007	0,225	0,117
119	248	115	0,193	0,028	-0,073	0,198	0,138

## NOAA-19

Idbalise	NbLocGlo	NBlocSel	meanError (km)	deltaLon (km)	deltaLat (km)	sigLon (km)	sigLat (km)
1	121	89	0,177	-0,024	0,123	0,144	0,137
108	197	156	0,109	0,025	0,006	0,088	0,098
109	112	68	0,267	0,015	0,078	0,22	0,286
110	143	88	0,195	-0,013	0,03	0,192	0,137
111	94	79	0,191	-0,018	-0,004	0,22	0,125
112	101	78	0,229	0,067	0,097	0,195	0,183
113	98	66	0,177	-0,006	0	0,151	0,16
116	79	61	0,202	-0,037	0,078	0,21	0,158
118	139	85	0,198	0,023	0,047	0,183	0,154
119	151	109	0,184	0,051	-0,052	0,188	0,156

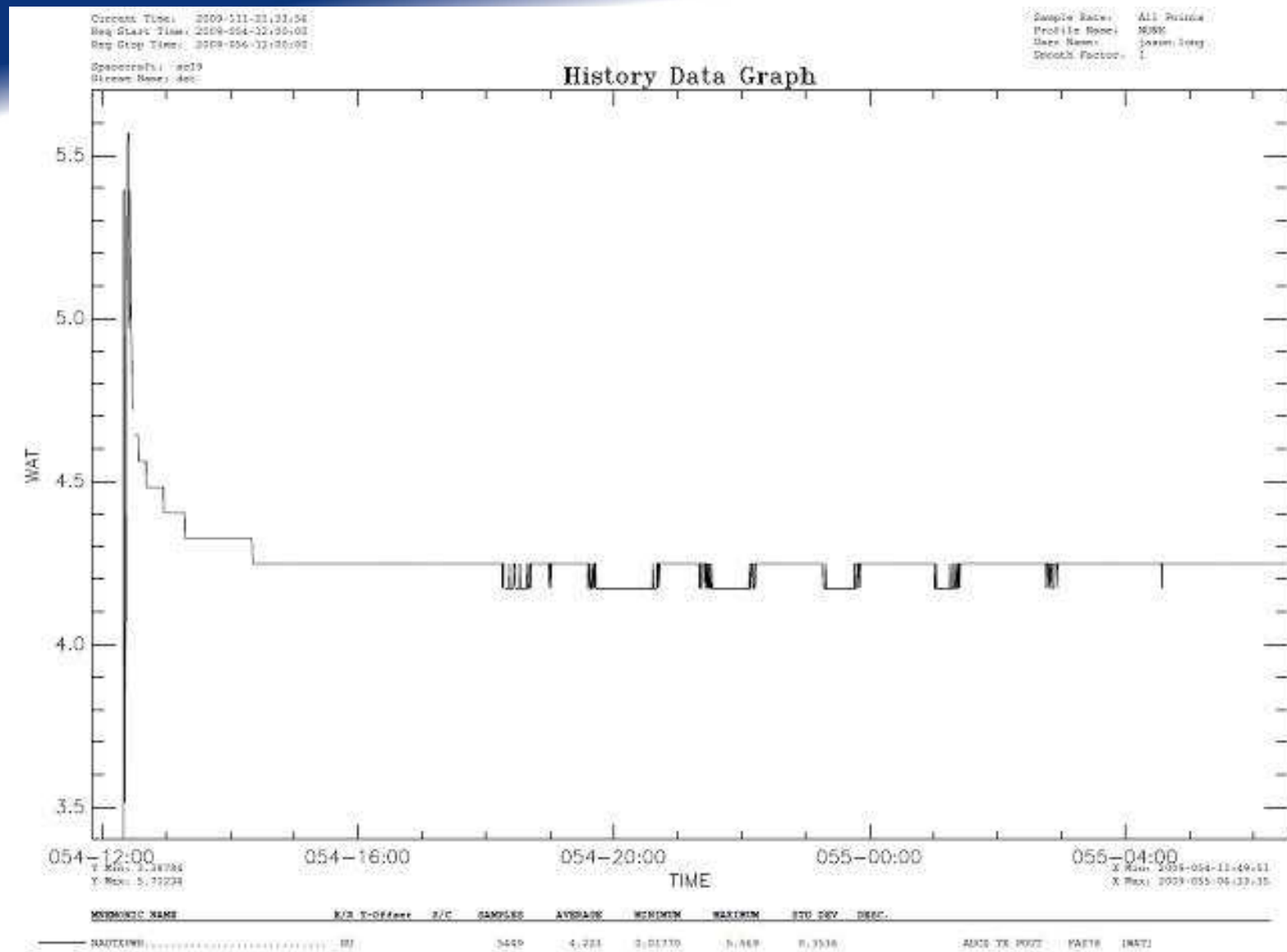


# NOAA-N' A-DCS Uplink Reception Probability (with no error in the message)



- Transmitter switch-on (TX1) between February 23 and March 2.
- Period of time used to evaluate interference with AICC
- Downlink signal is received but 5 to 10 dB lower than expected
- Transmitter (TX1) switch-on again on April 20 but signal is still lower and variable. TX1 switch-off on April 21.
- Transmitter (TX2) switch-on on April 27 : signal stays lower than expected. TX2 switch-off on April 29
- Expert Group to investigate anomaly : certainly a problem of matching at Transmitter output (RF switch , coaxial, antenna)
- New switch-on of TX1 on May 18 with several switch commands : TX2-TX1-TX2-TX1

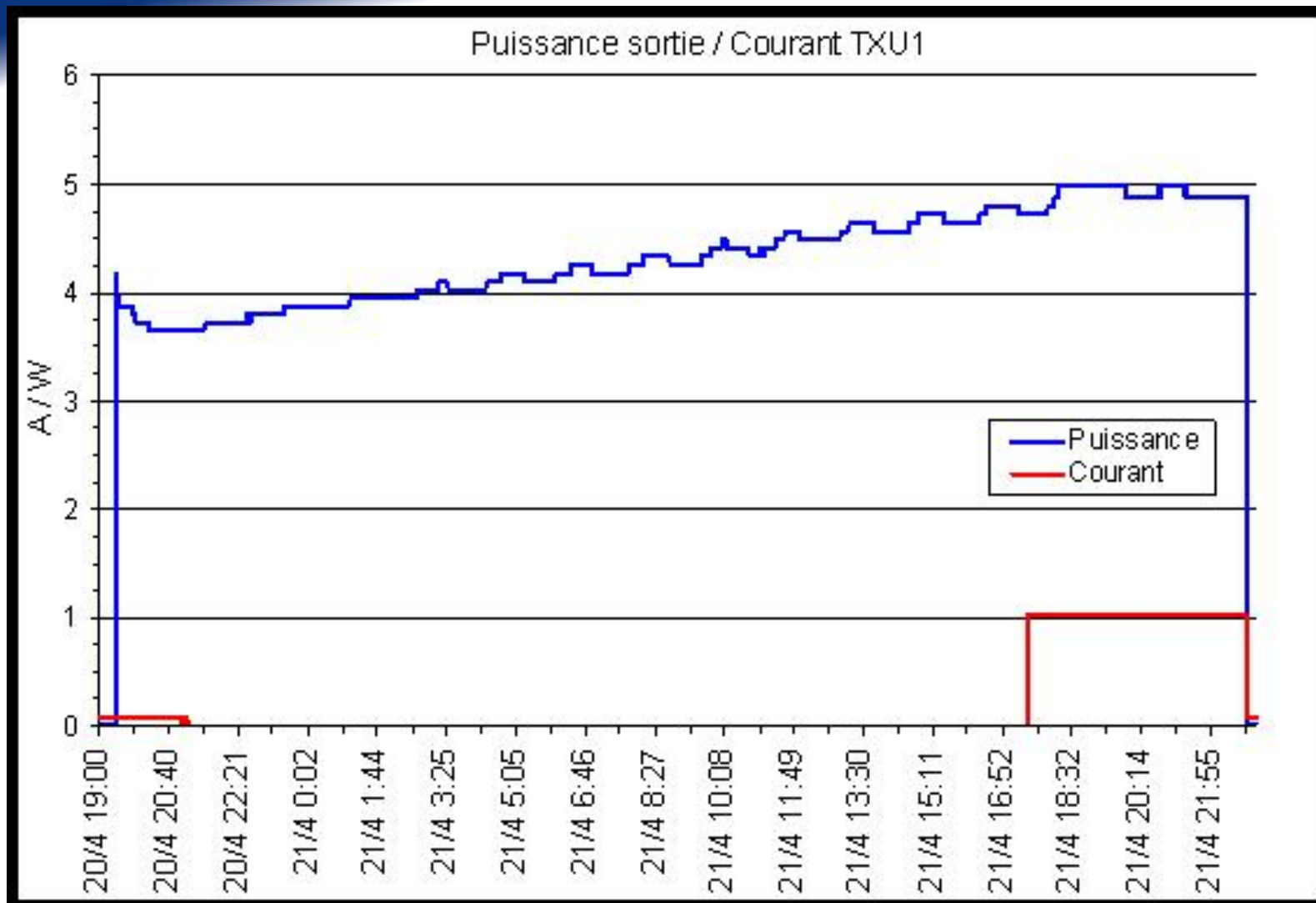
# A-DCS Downlink TX1 output power (February 2009)



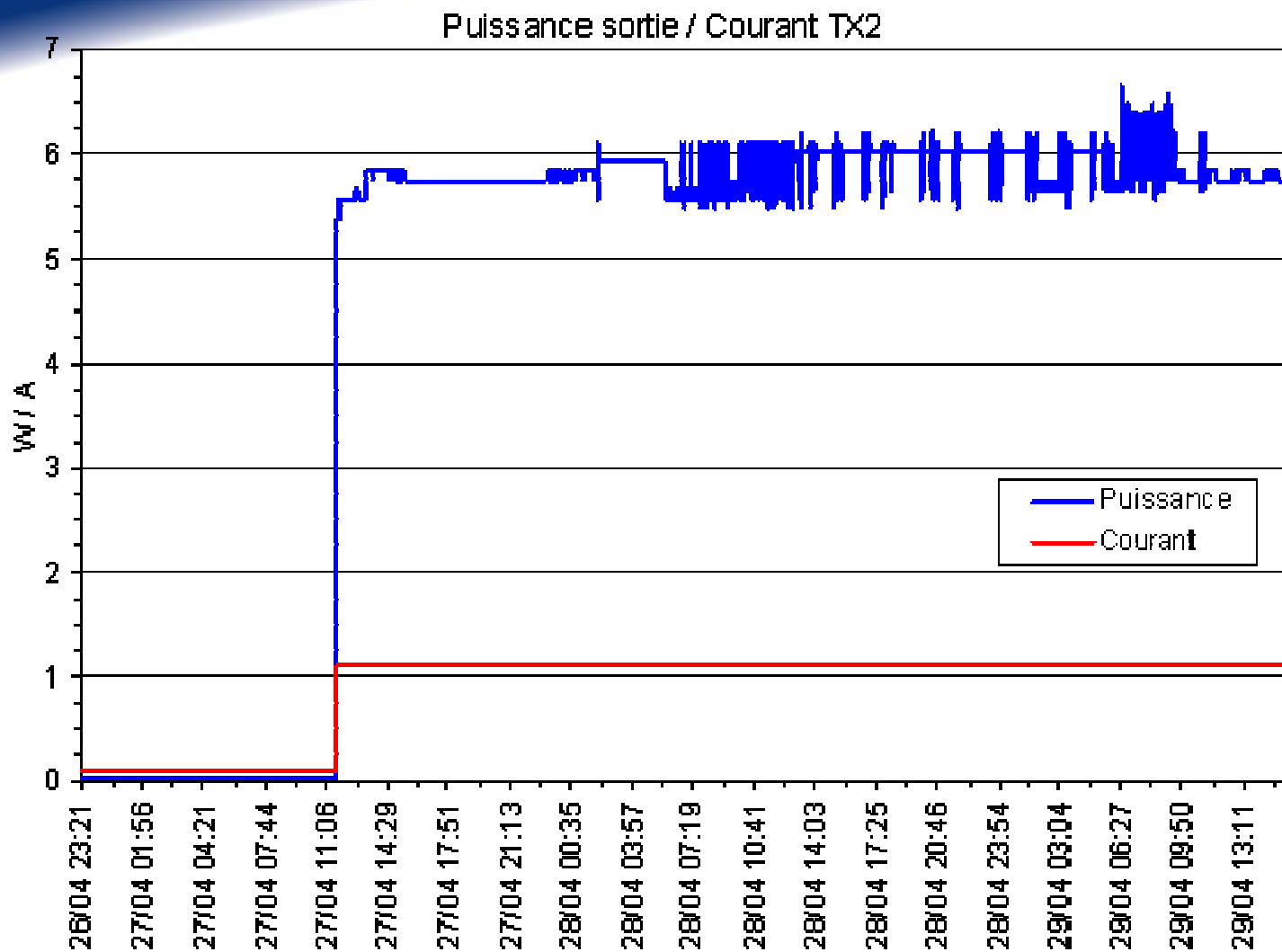
43rd ARGOS OF SCOM - 2 to 4 June 2009



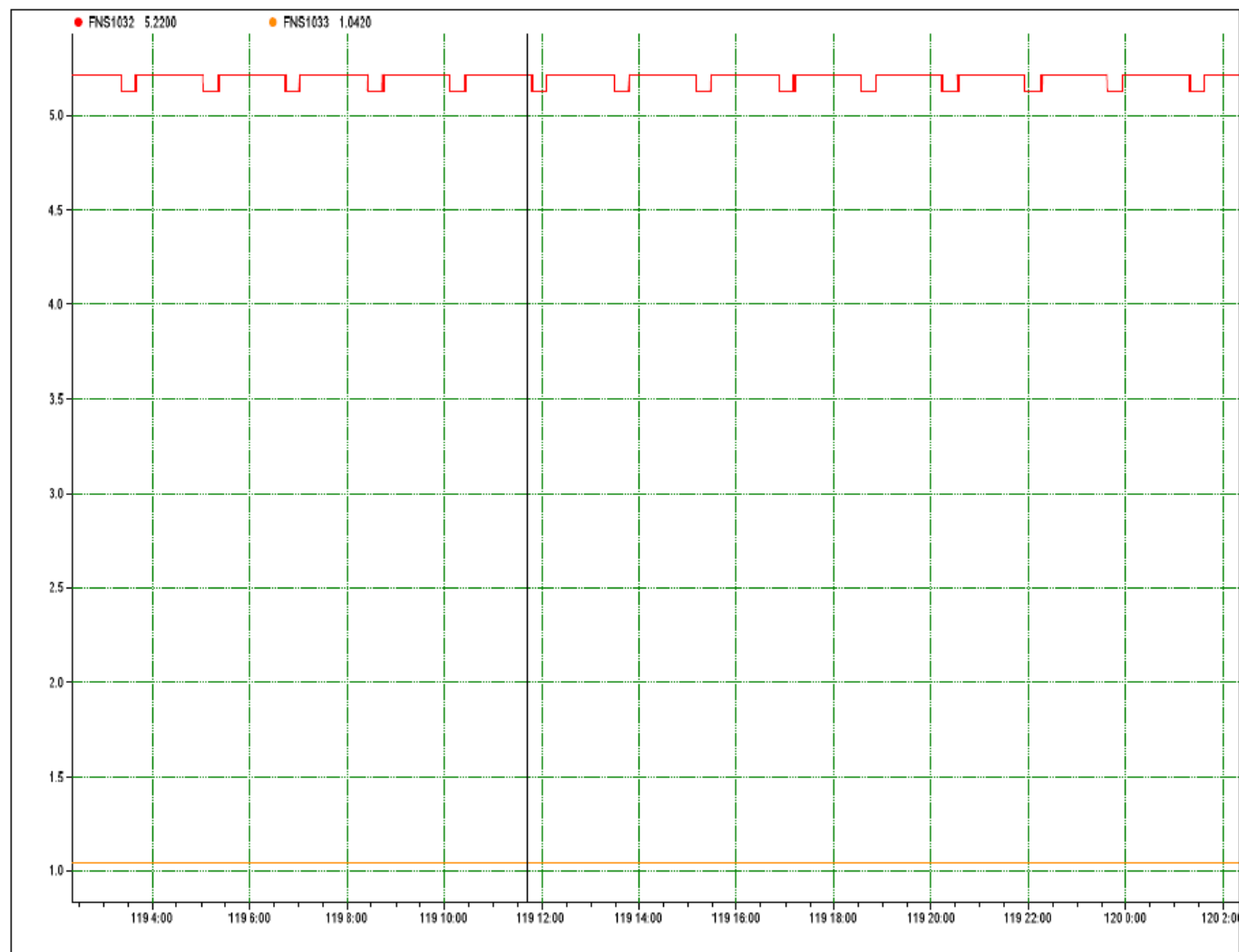
# A-DCS Downlink TX1 output power (20-21 April 2009)



# A-DCS Downlink TX2 output power (27-29 April 2009)

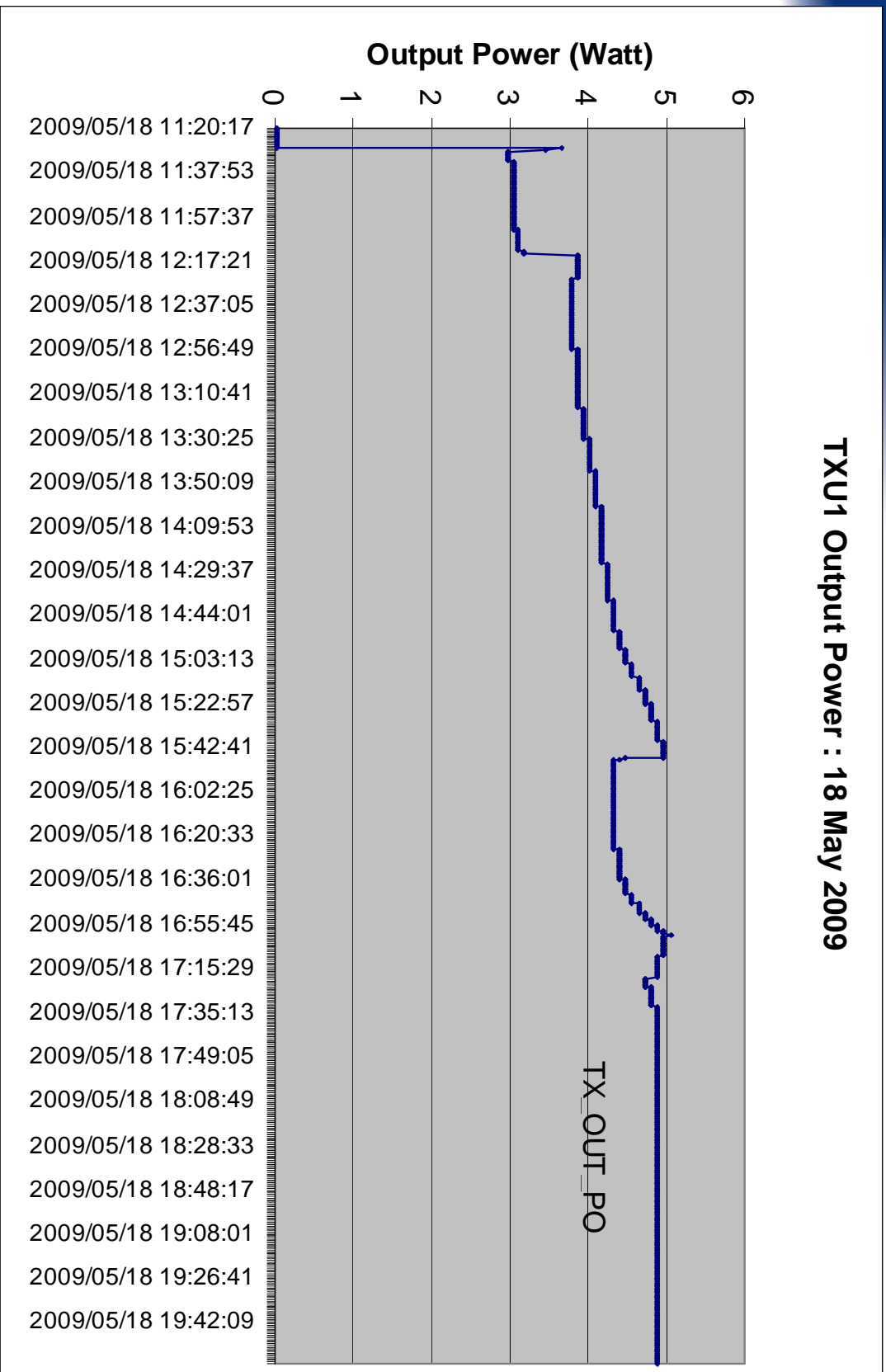


# A-DCS output power on METOP-A



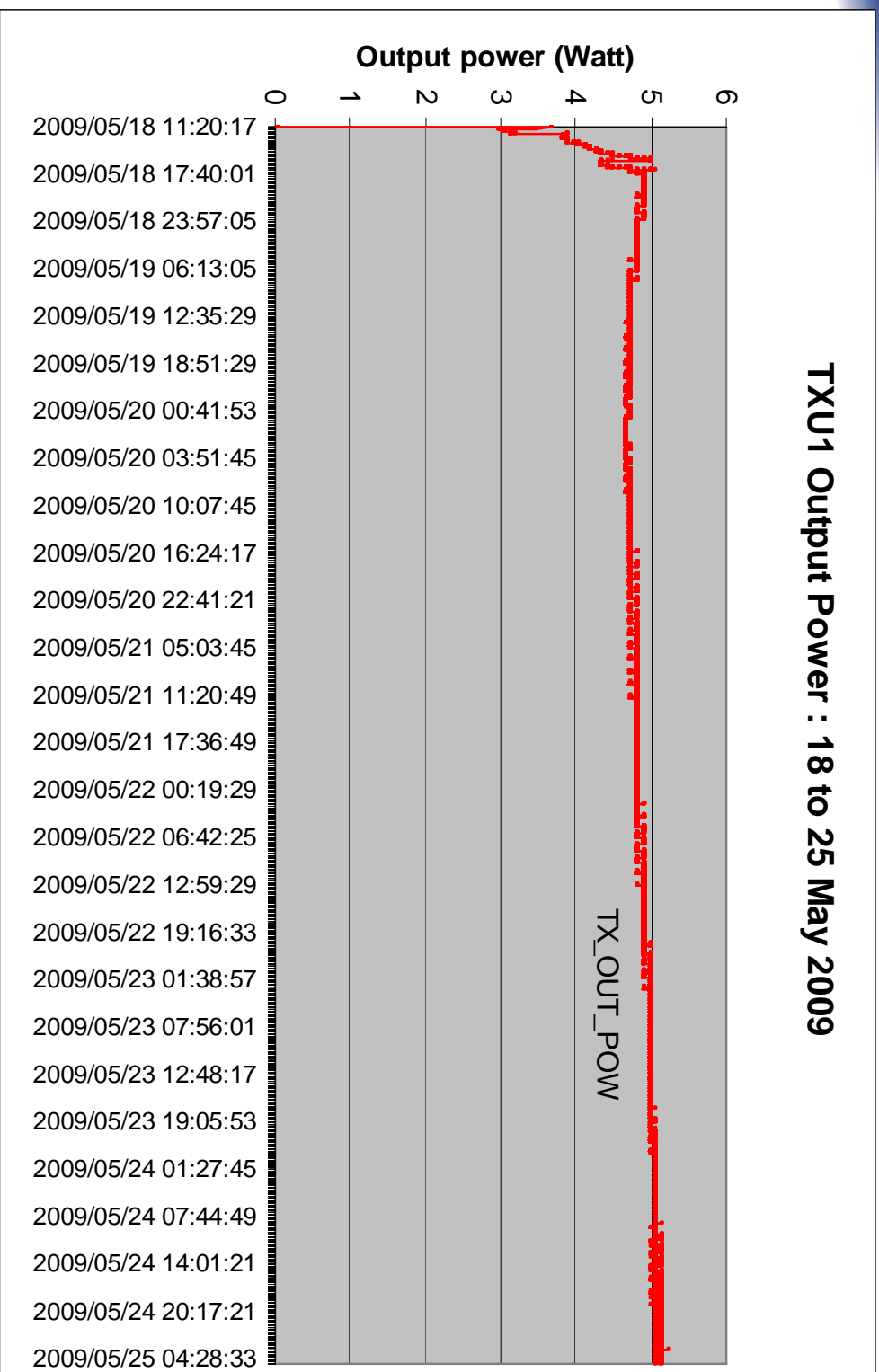
# A-DCS Downlink TX1 output power (May 2009)

TXU1 Output Power : 18 May 2009

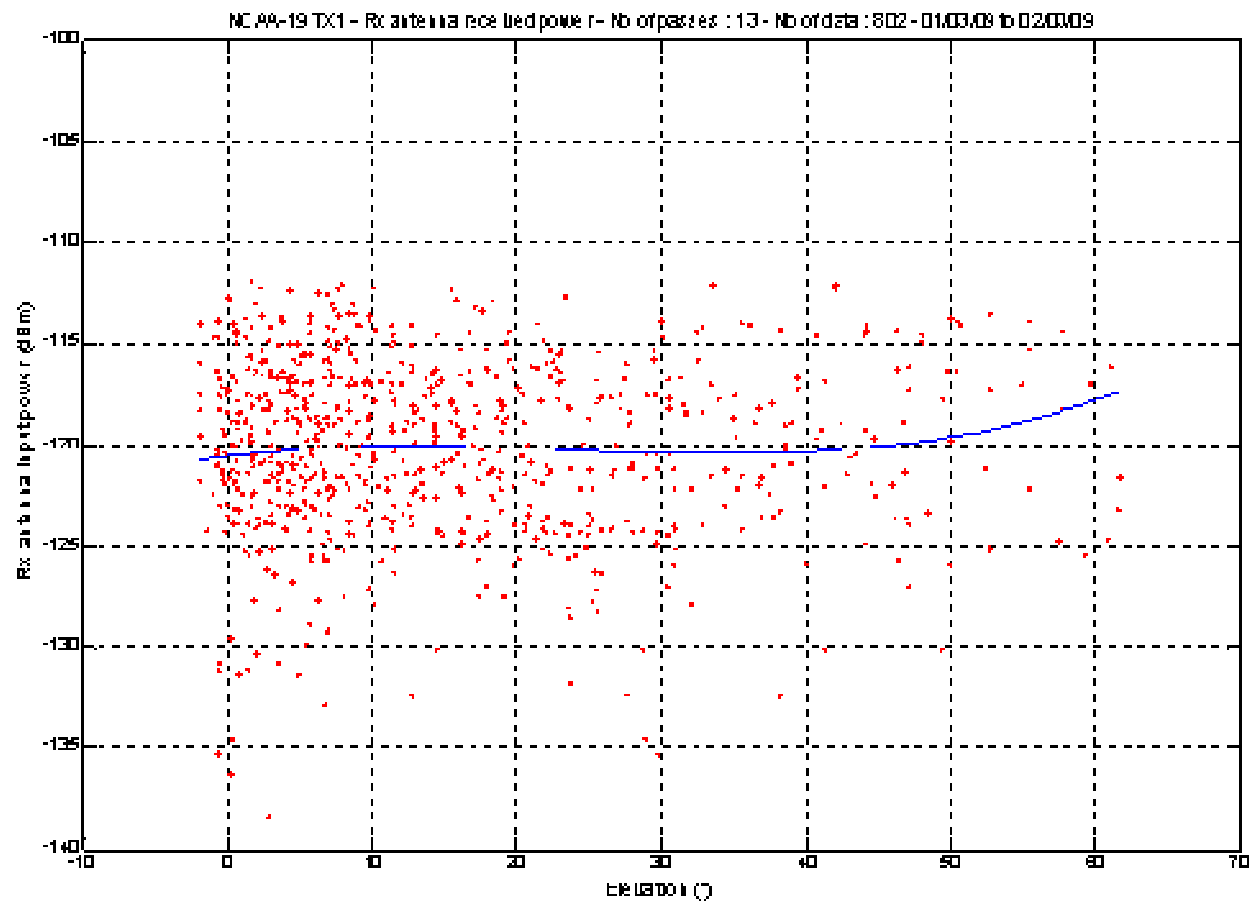


# A-DCS Downlink TX1 output power (May 2009)

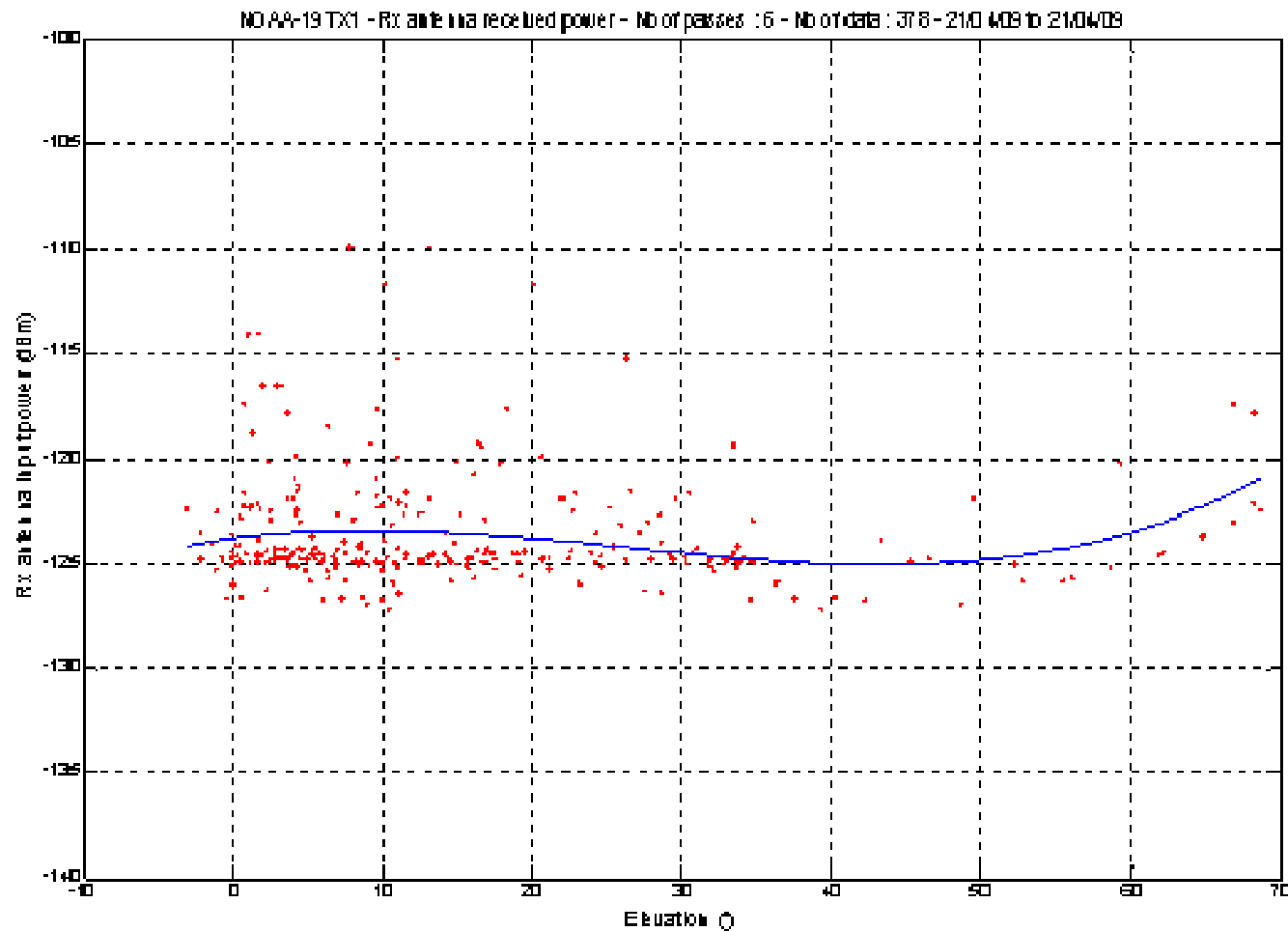
TXU1 Output Power : 18 to 25 May 2009



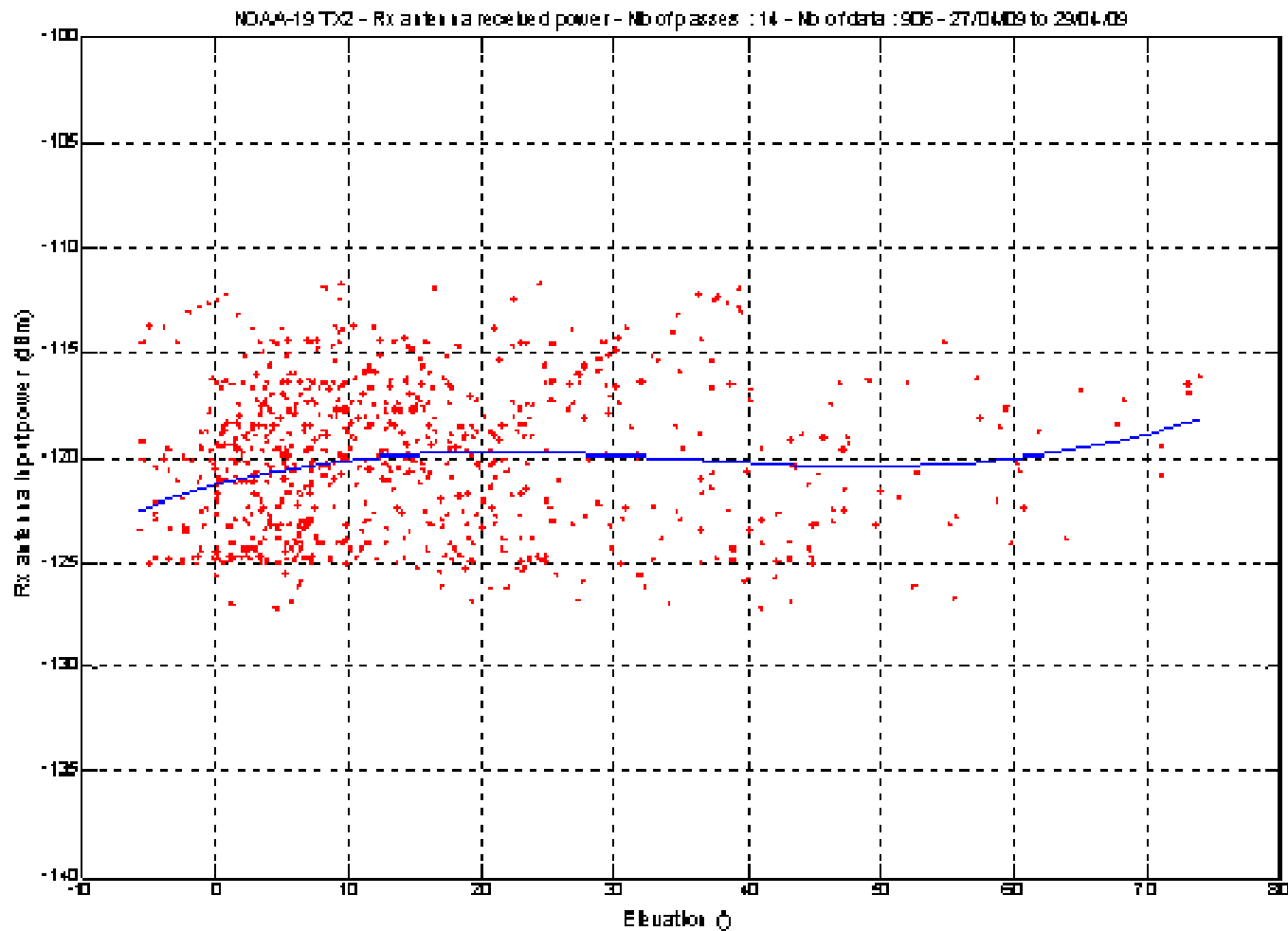
# A-DCS Downlink TX1 received level (February 2009)



# A-DCS Downlink TX1 received level (20-21 April 2009)

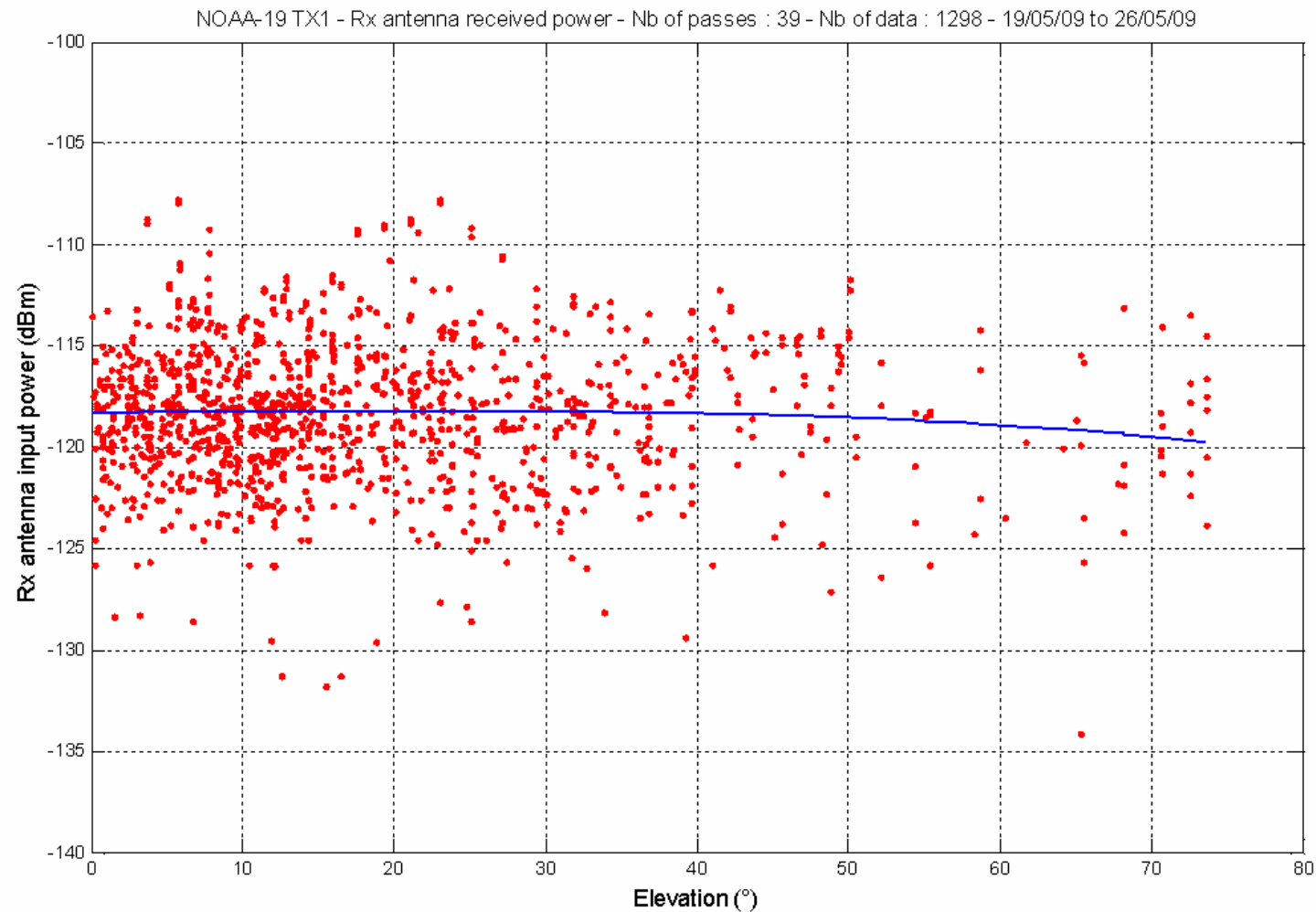


# A-DCS Downlink TX2 received level (27-29 April 2009)





# A-DCS Downlink TX1 received level (18-26 May 2009)



- **Reception of NOAA-N' downlink in Fairbanks and in Toulouse**
  - ◆ 60% of the messages in average
  - ◆ Typically between 40 and 80% depending on the satellite pass
  
- **Reception of Metop-A downlink in Toulouse**
  - ◆ 70-75% of the messages in average
  - ◆ Typically between 50 and 90% depending on the satellite pass